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**VARIABLES AFFECTING THE ACCEPTABILITY OF
IRRADIATION STERILIZED GROUND BEEF PRODUCTS
AND THE EFFECTS OF FLAVORED SALTS, PEPPER,
AND TEXTURED SOY PROTEIN**

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PREFACE

This report describes research conducted by members of the Irradiated Food Products Group, Radiation Preservation of Food Division, Food Engineering Laboratory, US Army, Natick Research and Development Command in 1977 and 1978.

It is being published now as the Army has expressed a need for irradiation sterilized meat products, (Loveridge, 1994). The data is relevant.

Ground beef patties were prepared with the addition of textured soy protein (TSP) and various flavorings. The added flavorings were: salt, pepper, onion salt and garlic salt. The beef patties were then irradiation sterilized and sensory tested by trained panels of eight persons. The sensory results were then combined in various ways to show the effect of the flavorings.

The addition of 20% TSP had no effect on sensory results except that it gave a preferred color. The addition of 0.2% pepper gave a more preferred product. The flavoring additions all gave a highly acceptable product with no preference shown for any of the flavorings.

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VARIABLES AFFECTING THE ACCEPTABILITY OF IRRADIATION STERILIZED GROUND BEEF PRODUCTS AND THE EFFECTS OF FLAVORED SALTS, PEPPER AND TEXTURED SOY PROTEIN

Introduction

The use of soy protein analogs as meat extenders is becoming more widespread (Pearson, 1973). By allowing the replacement of up to 30% of the ground beef in products in the school lunch program with a hydrated textured soy protein (TSP) containing 60 to 65% moisture, the United States Department of Agriculture's (USDA) Food and Nutrition Service has provided great impetus to its use (FNS Notice 219, 1971).

Problems of consumer acceptance of this form of product still exist. Cohen et al. (1976) investigated the effect of different levels of fat and TSP in a ground beef product containing salt and phosphates to improve juiciness. Their work was done with an irradiation sterilized ground beef product.

Cross et al. (1975) reported that beef patties with TSP at a 25% level of fat rated higher in tenderness than patties without TSP addition. Also, addition of TSP to beef patties did not significantly affect consumer panel ratings. Patties with 12.5 or 20% TSP levels had equal or superior palatability ratings when compared to patties without TSP.

This investigation deals with the effects of TSP addition at a 20% level and the addition of flavorings, salt, onion salt, garlic salt and pepper in various combinations, on the expert panel ratings of different sensory attributes and the total preference of an irradiation sterilized ground beef product.

Experimental Design

The samples of ground beef all contained the same amount of fat, approximately 9.5%. They also contained either no added TSP or 20% hydrated TSP (approximately 70% moisture). The TSP used is the fibrous product manufactured by Ral-Con Corporation. It has a dark brown color and contains 0.27 to 0.28% added phosphorous in the form of sodium tripolyphosphate (TPP) ($\text{Na}_5\text{P}_3\text{O}_{10}$).

The ground beef was prepared from USDA Choice whole rounds, consisting of semimembranosus, semitendinosus, and biceps femoris attached muscles, about seven to ten days post-mortem. They were trimmed to approximately 9.5% fat, cut into small pieces and ground through a 13 mm breaker plate. The rehydrated TSP was also ground through the same plate.

The ground meat was then mixed with 3.0% ice, TSP, TPP and flavorings (salt, onion salt, garlic salt and pepper in varying concentrations). Mixing was done in a Hobart Model No. H-600-D™ mixer for five minutes at moderate speed.

The mixed ground meat was then formed into patties, 120 + 2 g in weight and 52 + 2 mm in diameter. The patties were enzyme inactivated in a 245 + 10 °C oven for eight minutes on one side, turned and cooked for three minutes on the other side. An internal temperature of 80 + 5 °C was achieved.

Four ground beef patties were packed in a 404 x 309 size can, with epoxy-phenolic enamel, and sealed under a pressure of 7 + 1 kPa. The cans were held at -40 + 2 °C until irradiation processing.

The ground beef patties in cans were irradiated in a Co^{60} gamma ray source. They received a dose of 37 ± 10 ky at a processing temperature of -30 ± 2 °C and held at room temperature until tested by a trained panel of eight members. The samples were heated to 60 ± 3 °C before serving. The panelists were asked to rate the samples for the characteristics of odor, flavor, color, texture and appearance using an intensity scale of: 1 - extremely poor; 2 - very poor; 3 - poor; 4 - below fair, above poor; 5 - fair; 6 - below good, above fair; 7 - good; 8 - very good; 9 - excellent. In addition, preference ratings were obtained from the panels using a hedonic scale of one to nine with one meaning dislike extremely to nine meaning like extremely, Peryam and Pilgrim (1957). A rating of five "neither like nor dislike or above was considered to be acceptable for an irradiated ground beef patty.

Six products were served to the panelists at a temperature of 60 ± 3 °C. On any individual test, the patties were cut into quarter sections and served on a random basis to minimize any position effect. Each product was served on two different tests, with different products, to achieve a total number of 16 ratings. Table 1 lists the variables involved with the experiment. Table 2 lists the products served on each test. The eight-member panel was generally the same for each test. When all the results were obtained they were combined in various ways and the data was analyzed by analysis of variance as outlined by Snedecor and Cochran (1967).

The method of combining tests scores from different tests was decided upon as the best method for increasing the validity of the data and to achieve a large enough sample size with a minimum of tests.

Results and Discussion

Table 1 shows the ingredients in each sample.

Table 2 shows the combination of products tested on each panel test.

Table 3 lists the mean preference and sensory scores and their standard deviations for each of the 24 different tests, with a total of 16 panelists. The sensory scores are further analyzed for sample differences.

Table 4 shows the effects of TSP addition. Part A compares samples with 20% added TSP and without TSP, all without pepper. The product containing the TSP, brown in color, had significantly better color (0.01 level) than the sample without TSP. Part B shows the same comparison with the addition of 0.2% pepper. Again the color of the TSP added sample was significantly better (0.05 level). Both of these comparisons involved 96 scores. Part C combines the results of Parts A and B. The sample with the added TSP had significantly better color (0.01 level). No other characteristic showed any significant difference, but it should be noted that the TSP was dark brown. This comparison involved 192 scores.

Table 1 - Ingredients in Different Samples

<u>Sample Number</u>	<u>Percent</u>				
	<u>Pepper</u>	<u>Salt (NaCl)</u>	<u>Onion Salt</u>	<u>Garlic Salt</u>	<u>TSP</u>
1	0.0	0.8	0.0	0.0	0.0
2	0.2	0.8	0.0	0.0	0.0
3	0.0	0.0	0.8	0.0	0.0
4	0.2	0.0	0.8	0.0	0.0
5	0.0	0.4	0.4	0.0	0.0
6	0.2	0.4	0.4	0.0	0.0
7	0.0	0.0	0.0	0.8	0.0
8	0.2	0.0	0.0	0.8	0.0
9	0.0	0.4	0.0	0.4	0.0
10	0.2	0.4	0.0	0.4	0.0
11	0.0	0.0	0.4	0.4	0.0
12	0.2	0.0	0.4	0.4	0.0
13	0.0	0.8	0.0	0.0	20
14	0.2	0.8	0.0	0.0	20
15	0.0	0.0	0.8	0.0	20
16	0.2	0.0	0.8	0.0	20
17	0.0	0.4	0.4	0.0	20
18	0.2	0.4	0.4	0.0	20
19	0.0	0.0	0.0	0.8	20
20	0.2	0.0	0.0	0.8	20
21	0.0	0.4	0.0	0.4	20
22	0.2	0.4	0.0	0.4	20
23	0.0	0.0	0.4	0.4	20
24	0.2	0.0	0.4	0.4	20

Table 2 - Combinations of Products on Individual Tests (Eight Member Panels)

<u>Test Number</u>	<u>Combinations Tested</u>
1	1 2 3 4 7 8
2	5 6 9 10 11 12
3	2 4 6 8 10 12
4	1 3 5 7 9 11
5	13 14 15 16 19 20
6	17 18 21 22 23 24
7	14 16 18 20 22 24
8	13 15 17 19 21 23

Table 3 - Preference Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>	
1	5.8	1.3	
2	6.4	1.5	
3	6.0	1.5	
4	6.3	1.1	
5	5.7	1.2	<u>Analysis of Variance</u>
6	6.1	1.2	
7	6.4	1.2	$F = 0.90$ (NSD)
8	6.4	1.4	
9	6.1	1.1	
10	6.6	1.2	
11	6.0	1.3	
12	6.6	1.1	
13	6.3	1.3	
14	6.1	1.4	
15	5.8	1.7	
16	6.3	1.6	
17	6.8	0.9	
18	6.8	1.1	
19	5.9	1.2	
20	6.3	1.1	
21	6.4	1.6	
22	6.3	1.3	
23	6.4	1.3	
24	6.3	1.3	

Table 4 - Color Sensory Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Identity *</u>	
1	6.4	1.2	b,c,d	
2	6.5	1.6	b,c,d	
3	6.1	1.2	a,b	
4	6.4	1.2	b,c,d	
5	5.8	1.3	a	
6	6.3	1.1	a,b,c	<u>Analysis of Variance</u>
7	6.3	1.4	a,b,c	
8	6.5	1.5	b,c,d	$F = 2.35$
9	5.8	1.5	a	(0.01 significance)
10	6.6	1.0	b,c,d	
11	5.8	1.2	a	
12	6.8	0.9	c,d	
13	6.9	0.5	d	
14	6.8	0.9	c,d	
15	6.9	0.5	d	
16	6.9	0.5	d	
17	6.6	0.6	b,c,d	
18	6.9	0.9	d	
19	6.8	0.9	b,c,d	
20	6.9	0.6	d	
21	6.5	1.0	b,c,d	
22	6.8	0.6	c,d	
23	6.8	0.9	c,d	
24	6.8	0.7	c	

* Scores preceded by the same letter are not statistically different.

Table 5 - Odor Sensory Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>	
1	6.3	1.1	
2	6.4	1.0	
3	6.1	1.3	
4	6.6	1.0	
5	6.3	1.1	<u>Analysis of Variance</u>
6	6.3	1.4	$F = 0.90$ (NSD)
7	6.6	1.3	
8	6.7	1.3	
9	6.3	1.0	
10	6.6	1.2	
11	6.3	1.3	
12	6.8	1.0	
13	6.3	1.3	
14	6.2	1.1	
15	5.7	1.7	
16	6.6	1.5	
17	6.5	0.8	
18	6.6	0.7	
19	6.3	1.2	
20	6.6	1.2	
21	6.8	1.5	
22	6.5	1.0	
23	6.4	1.0	
24	6.4	1.0	

Table 6 - Flavor Sensory Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>
1	5.9	1.3
2	6.4	1.4
3	6.6	1.0
4	6.4	1.3
5	5.8	1.4
6	6.3	1.8
7	6.4	1.3
8	6.4	1.7
9	6.3	1.0
10	6.6	1.1
11	6.1	1.2
12	6.6	1.3
13	6.1	1.7
14	6.1	1.5
15	5.9	1.7
16	6.3	1.7
17	6.9	1.0
18	6.8	0.9
19	5.8	1.6
20	6.5	2.0
21	6.4	1.5
22	6.4	1.3
23	6.3	1.2
24	6.5	1.2

Analysis of Variance

$F = 0.69$ (NSD)

Table 7 - Texture Sensory Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Identity *</u>	
1	5.7	1.1	d	
2	6.7	1.0	b	
3	6.6	1.0	a,b	
4	6.6	1.4	a,b	<u>Analysis of Variance</u>
5	6.7	1.1	b	
6	6.6	1.3	a, b	$E = 1.78$
7	6.7	1.1	b	(0.05 significance)
8	6.7	1.2	b	
9	6.6	1.1	a,b	
10	6.8	1.1	b	
11	6.5	1.2	a,b	
12	6.9	0.8	b	
13	7.1	0.9	b	
14	6.6	0.8	a,b	
15	7.0	0.7	b	
16	7.0	0.9	b	
17	7.1	0.7	b	
18	6.9	0.6	b	
19	6.5	1.2	a	
20	6.9	0.8	b	
21	6.9	1.2	b	
22	6.8	0.9	b	
23	6.6	1.0	a,b	
24	6.8	0.9	b	

Scores preceded by the same letter are not statistically different

Table 8 - Appearance Sensory Scores for Individual Samples

<u>Sample</u>	<u>Mean</u>	<u>Standard Deviation</u>	
1	6.8	0.9	
2	6.8	1.3	
3	6.6	1.2	
4	6.6	1.3	<u>Analysis of Variance</u>
5	6.6	1.8	
6	6.7	2.0	$\bar{F} = 0.15$ (NSD)
7	6.6	1.2	
8	6.8	1.1	
9	6.7	1.2	
10	6.8	1.0	
11	6.7	1.1	
12	6.8	1.0	
13	6.9	0.7	
14	6.7	0.8	
15	6.8	0.7	
16	6.6	0.9	
17	6.7	0.8	
18	6.9	0.6	
19	6.6	0.9	
20	6.5	1.1	
21	6.7	1.1	
22	6.6	1.0	
23	6.6	1.0	
24	6.9	0.6	

Table 9 - Effect of TSP on Sensory Scores

	<u>Pref- erence</u>	<u>Color</u>	<u>Odor</u>	<u>Sensory Scores</u>			<u>N</u>	<u>Tested Products</u>			
				<u>Flavor</u>	<u>Texture</u>	<u>Appearance</u>					
<u>A. No Pepper</u>											
<u>a. 20% TSP,</u>											
<u>Mean</u>	6.3	6.7	6.2	6.2	6.9	6.7	96	13	15	17	
<u>SD</u>	1.3	0.8	1.3	1.5	1.0	0.9		19	21	23	
<u>b. 0% TSP,</u>											
<u>Mean</u>	6.0	6.0	6.4	6.1	6.6	6.7	96	1	3	5	
<u>SD</u>	1.2	1.3	1.1	1.2	1.1	1.0		7	9	11	
<u>F</u>	2.6	21.1**	0.8	0.6	2.4	0.1					
<u>B. 0.2% Pepper</u>											
<u>a. 20% TSP</u>											
<u>Mean</u>	6.4	6.9	6.5	6.4	6.8	6.7	96	14	16	18	
<u>SD</u>	1.3	0.6	1.1	1.3	0.8	1.1		20	22	24	
<u>b. 0% TSP</u>											
<u>Mean</u>	6.4	6.5	6.6	6.5	6.7	6.7	96	2	4	6	
<u>SD</u>	1.2	1.2	1.1	1.3	1.0	1.2		8	10	12	
<u>F</u>	0.1	6.4*	0.3	0.0	0.7	0.1					
<u>C. Combined Data of A. and B.</u>											
<u>a. 20% TSP</u>											
<u>Mean</u>	6.3	6.8	6.4	6.3	6.8	6.7	192	13	14	15	16
<u>SD</u>	1.3	0.7	1.2	1.4	0.9	0.9		17	18	19	20
								21	22	23	24
<u>b. 0% TSP</u>											
<u>Mean</u>	6.2	6.3	6.5	6.3	6.7	6.7	192	1	2	3	4
<u>SD</u>	1.2	1.3	1.1	1.9	1.1	1.0		5	6	7	8
								9	10	11	12
<u>F</u>	1.0	25.3**	1.0	0.	1.0	0.0					

* 0.05 % significance

** 0.01 significance

Table 10 shows the effects of pepper addition. Part A compares samples without TSP. The product with 0.2% pepper addition was significantly better for preference (0.05 level), color (0.01 level) and flavor (0.05 level). No other characteristic was significantly affected. Part B compares samples with 20% added TSP. There were no significant differences. Part C combines the results for Parts A and B. The samples with the added pepper were significantly preferred (0.05 level), had better color (0.01 level), better odor (0.05 level) and better flavor (0.05 level). No other differences were shown. Parts A and B used 96 scores. Part C used 192 scores.

Tables 11 to 16 show the effect of the addition of the various flavorings on sensory scores. In all the tables, Part A is the data for the combinations of TSP addition. Part a has no added pepper. Part b has 0.2% added pepper. Part B is the data for the combinations of pepper addition. Part c has no added TSP. Part d has 20% added TSP. No significant differences were shown for any of these scores. Each score is the mean of 32 panelist ratings.

Table 17 combines the flavoring scores to ignore the effect of pepper or TSP addition. Again, no significant differences occurred. A total of 64 panelist ratings were evaluated.

All the sensory scores showed that the patties prepared in this manner were quite acceptable. The scores were generally above 6.0. The range was 5.7 to 7.1 for all the variables evaluated.

The addition of 0.2% pepper gave a more preferred product. The addition of 20% TSP had no effect on organoleptic results except that it gave a preferred color. The flavoring additions gave a highly acceptable product, but no preferences were shown for any of the flavors.

Table 10 - Effect of Pepper on Sensory Scores

	<u>Pref- erence</u>	<u>Sensory Scores</u>					<u>N</u>	<u>Tested Products</u>			
		<u>Color</u>	<u>Odor</u>	<u>Flavor</u>	<u>Texture</u>	<u>Appearance</u>					
<u>A. No TSP</u>											
<u>a. 0.2% Pepper Addition</u>											
<u>Mean</u>	6.4	6.5	6.6	6.5	6.7	6.7	96	2	4	6	
<u>SD</u>	1.2	1.2	1.1	1.3	1.0	1.2		8	10	12	
<u>b. 0% Pepper Addition</u>											
<u>Mean</u>	6.0	6.0	6.4	6.1	6.6	6.7	96	1	3	5	
<u>SD</u>	1.2	1.3	1.1	1.2	1.1	1.0		7	9	11	
<u>F</u>	6.1*	6.7**	1.5	4.0	0.3	0.1					
<u>B. 20% TSP</u>											
<u>a. 0.2% Pepper Addition</u>											
<u>Mean</u>	6.4	6.9	6.5	6.4	6.8	6.7	96	14	16	18	
<u>SD</u>	1.3	0.8	1.3	1.5	1.0	0.9		20	22	24	
<u>b. 0% Pepper</u>											
<u>Mean</u>	6.3	6.7	6.2	6.2	6.9	6.7	96	13	15	17	
<u>SD</u>	1.3	0.8	1.3	1.5	1.0	0.9		19	21	23	
<u>F</u>	0.3	1.6	2.5	0.9	0.1	0.0					
<u>C. Combined Data of Parts A and B</u>											
<u>a. 0.2% Pepper Addition</u>											
<u>Mean</u>	6.4	6.7	6.5	6.4	6.8	6.7	192	2	4	6	8
<u>SD</u>	1.3	1.0	1.1	1.7	0.9	0.9		10	12	14	16
								18	20	22	24
<u>b. 0% Pepper Addition</u>											
<u>Mean</u>	6.1	6.4	6.3	6.2	6.7	6.7	192	1	3	5	7
<u>SD</u>	1.3	1.6	1.2	1.4	1.0	0.9		9	11	13	15
								17	19	21	23
<u>F</u>	4.2*	7.7**	4.0	4.2*	0.1	0.0					

* - 0.05 significance

** 0.01 significance

Table 11 - Effect of Added Flavorings on Preference Scores

Pepper	TSP	Percent Additives			Mean	SD	N	Tested	
		Salt (NaCl)	Onion Salt	Garlic Salt				Products	
<u>A. TSP Addition</u>									
<u>a. No Added Pepper</u>									
0.0	NA	0.8	0.0	0.0	6.0	1.3	32	1	13
0.0	NA	0.0	0.8	0.0	5.9	1.6	32	3	15
0.0	NA	0.0	0.0	0.8	6.1	1.2	32	7	19
0.0	NA	0.4	0.4	0.0	6.2	1.2	32	5	17
0.0	NA	0.0	0.4	0.4	6.2	1.3	32	11	23
0.0	NA	0.4	0.0	0.4	6.2	1.3	32	9	21
$\bar{F} = 0.3$ (NSD)									
<u>b. 0.2 % Added Pepper</u>									
0.2	NA	0.8	0.0	0.0	6.3	1.4	32	2	14
0.2	NA	0.0	0.8	0.0	6.3	1.3	32	4	16
0.2	NA	0.0	0.0	0.8	6.4	1.2	32	8	20
0.2	NA	0.4	0.4	0.8	6.5	1.2	32	6	18
0.2	NA	0.0	0.4	0.4	6.5	1.2	32	12	24
0.2	NA	0.4	0.0	0.4	6.4	1.2	32	10	22
$F = 0.2$ (NSD)									
<u>B. Pepper Addition</u>									
<u>c. No Added TSP</u>									
NA	0	0.8	0.0	0.0	6.1	1.4	32	1	2
NA	0	0.0	0.8	0.0	6.1	1.3	32	3	4
NA	0	0.00	0.0	0.8	6.4	1.3	32	7	8
NA	0	0.4	0.4	0.0	5.9	1.2	32	5	6
NA	0	0.0	0.4	0.4	6.3	1.2	32	11	12
NA	0	0.34	0.0	0.4	6.3	1.1	32	9	10
$F = 0.7$ (NSD)									
<u>d. 20% Added TSP</u>									
NA	20	0.8	0.0	0.0	6.2	1.3	32	13	14
NA	20	0.0	0.8	0.0	6.0	1.6	32	15	16
NA	20	0.0	0.0	0.8	6.1	1.2	32	19	20
NA	20	0.4	0.4	0.0	6.8	1.0	32	17	18
NA	20	0.0	0.4	0.4	6.4	1.3	32	23	24
NA	20	0.4	0.0	0.4	6.3	1.4	32	21	22
$F = 1.4$ (NSD)									

Table 12 - Effect of Added Flavorings on Sensory Color Scores

Percent Additives								Tested	
Pepper	TSP	Salt (NaCl)	Onion Salt	Garlic Salt	Mean	SD	N	Products	
A. TSP Addition									
a. No Added Pepper									
0.0	NA	0.8	0.0	0.0	6.7	0.9	32	1	13
0.0	NA	0.0	0.8	0.0	6.5	1.0	32	3	15
0.0	NA	0.0	0.0	0.8	6.2	1.1	32	7	19
0.0	NA	0.4	0.4	0.0	6.2	1.1	32	5	17
0.0	NA	0.0	0.4	0.4	6.3	1.1	32	11	23
0.0	NA	0.4	0.0	0.4	6.1	1.3	32	9	21
$F = 1.1$ (NSD)									
b. 0.2% Added Pepper									
0.2	NA	0.8	0.0	0.0	6.7	1.2	32	2	14
0.2	NA	0.0	0.8	0.0	6.6	0.9	32	4	16
0.2	NA	0.0	0.0	0.8	6.7	1.1	32	8	20
0.2	NA	0.4	0.4	0.0	6.6	1.0	32	6	18
0.2	NA	0.0	0.4	0.4	6.8	0.8	32	12	24
0.2	NA	0.4	0.0	0.4	6.7	0.8	32	10	22
$F = 0.1$ (NSD)									
B. Pepper Addition									
c. No Added TSP									
NA	0	0.8	0.0	0.0	6.5	1.3	32	1	2
NA	0	0.0	0.8	0.0	6.3	1.2	32	3	4
NA	0	0.0	0.0	0.8	6.4	1.4	32	7	8
NA	0	0.4	0.4	0.0	6.1	1.2	32	5	6
NA	0	0.0	0.4	0.4	6.3	1.2	32	11	12
NA	0	0.4	0.0	0.4	6.2	1.3	32	9	10
$F = 0.4$ (NSD)									
d. 20% Added TSP									
NA	20	0.8	0.0	0.0	6.8	0.7	32	13	14
NA	20	0.0	0.8	0.0	6.9	0.5	32	15	16
NA	20	0.0	0.0	0.8	6.8	0.7	32	19	20
NA	20	0.4	0.4	0.0	6.8	0.7	32	17	18
NA	20	0.0	0.4	0.4	6.8	0.8	32	23	24
NA	20	0.4	0.0	0.4	6.6	0.8	32	21	22
$F = 0.5$ (NSD)									

Table 13 - Effect of Added Flavorings on Sensory Odor Scores

Percent Additive					Mean	SD	N	Tested	
Pepper	TSP	Salt (NaCl)	Onion Salt	Garlic Salt				Products	
A. TSP Addition									
a. No Added Pepper									
0.0	NA	0.8	0.0	0.0	6.3	1.2	32	1	13
0.0	NA	0.0	0.8	0.0	6.1	1.5	32	3	15
0.0	NA	0.0	0.0	0.8	6.4	1.0	32	7	19
0.0	NA	0.4	0.4	0.0	6.4	1.0	32	5	17
0.0	NA	0.0	0.4	0.4	6.3	1.1	32	11	23
0.0	NA	0.4	0.0	0.4	6.3	1.2	32	9	21
$F = 0.2$ (NSD)									
b. 0.2% Added Pepper									
0.2	NA	0.8	0.0	0.0	6.3	1.0	32	2	14
0.2	NA	0.0	0.8	0.0	6.6	1.2	32	4	16
0.2	NA	0.0	0.0	0.8	6.6	1.2	32	8	20
0.2	NA	0.4	0.4	0.0	6.5	1.1	32	6	18
0.2	NA	0.0	0.4	0.4	6.6	1.0	32	12	24
0.2	NA	0.4	0.0	0.4	6.6	1.1	32	10	22
$F = 0.4$ (NSD)									
B. Pepper Addition									
c. No Added TSP									
NA	0	0.8	0.0	0.0	6.3	1.0	32	1	2
NA	0	0.0	0.8	0.0	6.6	1.0	32	3	4
NA	0	0.0	0.0	0.8	6.6	1.3	32	7	8
NA	0	0.4	0.4	0.0	6.3	1.3	32	5	6
NA	0	0.0	0.4	0.4	6.5	1.1	32	11	12
NA	0	0.4	0.0	0.4	6.5	1.0	32	9	10
$F = 0.5$ (NSD)									
d. 20% Added TSP									
NA	20	0.8	0.0	0.0	6.3	1.2	32	13	14
NA	20	0.0	0.8	0.0	6.2	1.6	32	15	16
NA	20	0.0	0.0	0.8	6.4	1.2	32	19	20
NA	20	0.4	0.4	0.0	6.6	0.8	32	17	18
NA	20	0.0	0.4	0.4	6.4	1.0	32	23	24
NA	20	0.4	0.0	0.4	6.3	1.3	32	21	22
$F = 0.4$ (NSD)									

Table 14 - Effect of Added Flavorings on Sensory Flavor Scores

Pepper	TSP	Percent Additives			Mean	SD	N	Tested	
		Salt (NaCl)	Onion Salt	Garlic Salt				Products	
A. TSP Addition									
a. No Added Pepper									
0.0	NA	0.8	0.0	0.0	6.0	1.5	32	1	13
0.0	NA	0.0	0.8	0.0	6.0	1.5	32	3	15
0.0	NA	0.0	0.0	0.8	6.3	1.3	32	7	19
0.0	NA	0.4	0.4	0.0	6.3	1.3	32	5	17
0.0	NA	0.0	0.4	0.4	6.2	1.2	32	11	23
0.0	NA	0.4	0.0	0.4	6.4	1.2	32	9	21
$F = 0.5$ (NSD)									
b. 0.2% Added Pepper									
0.2	NA	0.8	0.0	0.0	6.3	1.4	32	2	14
0.2	NA	0.0	0.8	0.0	6.3	1.5	32	4	16
0.2	NA	0.0	0.0	0.8	6.5	1.4	32	8	20
0.2	NA	0.4	0.4	0.0	6.5	1.1	32	6	18
0.2	NA	0.0	0.4	0.4	6.6	1.2	32	12	24
0.2	NA	0.4	0.0	0.4	6.5	1.2	32	10	22
$F = 0.3$ (NSD)									
B. Pepper Addition									
c. No Added TSP									
NA	0.0	0.8	0.0	0.0	6.1	1.4	32	1	2
NA	0.0	0.0	0.8	0.0	6.2	1.3	32	3	4
NA	0.0	0.0	0.0	0.8	6.4	1.5	32	7	8
NA	0.0	0.4	0.4	0.0	6.0	1.3	32	5	6
NA	0.0	0.0	0.4	0.4	6.3	1.2	32	11	12
NA	0.0	0.4	0.0	0.4	6.5	1.0	32	9	10
$F = 0.6$ (NSD)									
d. 20% Added TSP									
NA	20	0.8	0.0	0.0	6.1	1.5	32	13	14
NA	20	0.0	0.8	0.0	6.1	1.7	32	15	16
NA	20	0.0	0.0	0.8	6.1	1.4	32	19	20
NA	20	0.4	0.4	0.0	6.8	1.0	32	17	18
NA	20	0.0	0.4	0.4	6.4	1.2	32	23	24
NA	20	0.4	0.4	0.4	6.4	1.4	32	21	22
$F = 1.3$ (NSD)									

Table 15 - Effect of Added Flavorings on Sensory Texture Scores

Percent Additives					Mean	SD	N	Tested Products
Pepper	TSP	Salt (NaCl)	Onion Salt	Garlic Salt				
A. TSP Addition								
a. No Added Pepper								
0.0	NA	0.8	0.0	0.0	6.9	1.0	32	1 13
0.0	NA	0.0	0.8	0.0	6.8	0.9	32	3 15
0.0	NA	0.0	0.0	0.8	6.9	0.9	32	7 19
0.0	NA	0.4	0.4	0.0	6.9	0.9	32	5 17
0.0	NA	0.0	0.4	0.4	6.6	1.1	32	11 23
0.0	NA	0.4	0.0	0.4	6.8	1.1	32	9 21
$F = 0.6$ (NSD)								
b. 0.2% Added Pepper								
0.2	NA	0.8	0.0	0.0	6.7	0.9	32	2 14
0.2	NA	0.0	0.8	0.0	6.8	0.9	32	4 16
0.2	NA	0.0	0.0	0.8	6.8	1.0	32	8 20
0.2	NA	0.4	0.4	0.0	6.7	1.0	32	6 18
0.2	NA	0.0	0.4	0.4	6.8	0.9	32	12 24
0.2	NA	0.4	0.0	0.4	6.8	0.9	32	10 22
$F = 0.2$ (NSD)								
B. Pepper Addition								
c. No Added TSP								
NA	0.0	0.8	0.0	0.0	6.7	1.0	32	1 2
NA	0.0	0.8	0.8	0.0	6.6	1.0	32	3 4
NA	0.0	0.0	0.0	0.8	6.7	1.1	32	7 8
NA	0.0	0.4	0.4	0.0	6.6	1.2	32	5 6
NA	0.0	0.0	0.4	0.4	6.7	1.0	32	11 12
NA	0.0	0.4	0.0	0.4	6.7	1.1	32	9 10
$F = 0.1$ (NSD)								
d. 20% Added TSP								
NA	20	0.8	0.0	0.0	6.8	0.9	32	13 14
NA	20	0.0	0.8	0.0	7.0	0.8	32	15 16
NA	20	0.0	0.0	0.8	6.7	1.0	32	19 20
NA	20	0.4	0.4	0.0	7.0	0.6	32	17 18
NA	20	0.0	0.4	0.4	6.7	1.0	32	23 24
NA	20	0.4	0.0	0.4	6.8	1.0	32	21 22
$F = 0.7$ (NSD)								

Table 16 - Effect of Added Flavorings on Sensory Appearance Scores

Percent Additives					Mean	SD	N	Tested	
Pepper	TSP	Salt (NaCl)	Onion Salt	Garlic Salt				Products	
A. TSP Addition									
a. No Added Pepper									
0.0	NA	0.8	0.0	0.0	6.8	0.8	32	1 3	
0.0	NA	0.0	0.8	0.0	6.7	1.0	32	3 15	
0.0	NA	0.0	0.0	0.8	6.6	1.0	32	7 19	
0.0	NA	0.4	0.4	0.0	6.6	1.0	32	5 17	
0.0	NA	0.0	0.4	0.4	6.7	1.1	32	11 3	
0.0	NA	0.4	0.0	0.4	6.7	1.1	32	9 21	
$F = 0.2$ (NSD)									
b. 0.2% Added pepper									
0.2	NA	0.8	0.0	0.0	6.7	0.9	32	2 14	
0.2	NA	0.0	0.8	0.0	6.6	1.1	32	4 16	
0.2	NA	0.0	0.0	0.8	6.7	1.1	32	7 8	
0.2	NA	0.4	0.4	0.0	6.6	1.1	32	5 6	
0.2	NA	0.0	0.4	0.4	6.8	1.0	32	11 12	
0.2	NA	0.4	0.0	0.4	6.7	1.1	32	9 10	
$F = 0.3$ (NSD)									
B. Pepper Addition									
a. No Added TSP									
NA	0.0	0.8	0.0	0.0	6.8	0.9	32	1 2	
NA	0.0	0.0	0.8	0.0	6.6	1.2	32	3 4	
NA	0.0	0.0	0.0	0.8	6.7	1.1	32	7 8	
NA	0.0	0.4	0.4	0.0	6.6	1.1	32	5 6	
NA	0.0	0.0	0.4	0.4	6.8	1.0	32	11 12	
NA	0.0	0.4	0.0	0.4	6.7	1.1	32	9 10	
$F = 0.1$ (NSD)									
b. 20% Added TSP									
NA	20	0.8	0.0	0.0	6.8	0.8	32	13 14	
NA	20	0.0	0.8	0.0	6.7	0.8	32	15 16	
NA	20	0.0	0.0	0.8	6.5	1.0	32	19 20	
NA	20	0.4	0.4	0.0	6.8	0.7	32	17 18	
NA	20	0.0	0.4	0.4	6.8	0.8	32	23 24	
NA	20	0.4	0.0	0.4	6.7	1.0	32	21 22	
$F = 0.4$ (NSD)									

Table 17 - Effect of Salt, Onion Salt and Garlic Salt on Sensory Scores

Percent Additive			Pref- erence	Color	Odor	Flavor	Texture	Appear- ance	Tested Products
Salt (NaCl)	Onion Salt	Garlic Salt							
0.8	0.0	0.0							1 12 13 24
		mean	6.1	6.7	6.3	6.1	6.8	6.8	
		SD	1.4	1.1	1.1	1.4	1.0	0.8	
0.0	0.8	0.0							3 4 15 16
		mean	6.1	6.6	6.4	6.1	6.8	6.7	
		SD	1.4	0.9	1.4	1.5	0.9	1.0	
0.0	0.0	0.8							7 8 19 20
		mean	6.3	6.6	6.5	6.3	6.7	6.6	
		SD	1.2	1.1	1.4	1.4	1.1	1.0	
0.4	0.4	0.0							5 6 17 18
		mean	6.3	6.4	6.4	6.4	6.8	6.7	
		SD	1.2	1.1	1.0	1.2	0.9	0.9	
0.0	0.4	0.4							11 12 23 24
		mean	6.3	6.5	6.5	6.4	6.7	6.8	
		SD	1.2	1.0	1.1	1.2	1.0	0.9	
0.4	0.0	0.4							9 10 21 22
		mean	6.3	6.4	6.	6.4	6.8	6.7	
		SD	1.3	1.1	1.2	1.2	1.0	1.1	
		<i>F</i>	0.5	0.6	0.3	0.6	0.2	0.2	

All scores showed no significant differences. Mean of 64 scores.

Table 8 shows the proximate analysis and phosphate content of the samples using standard AOAC methods (1970). The analyses showed that the TSP containing ground beef is well matched to water, total protein and fat content.

Table 18 - Proximate Analysis of Raw Product

TSP Added	Percent Water	Percent Protein	Percent Fat	Percent Ash	Percent Fiber	Percent Phosphorous
no	68.7	20.3	9.3	1.6	0.1	0.28
yes	68.8	20.2	9.6	1.5	0.1	0.27

Summary

These sensory studies show that a highly acceptable irradiation sterilized ground beef product can be prepared with the addition of different flavorings. TSP can also be used in the product preparation.

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